(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : **0 478 222 A2**

(12) EUROPEAN PATENT APPLICATION

(21) Application number : **91308539.5**

(22) Date of filing : **19.09.91**

(51) Int. Cl.[5] : **G11B 7/135**, G11B 7/12, G11B 7/13

(30) Priority : **27.09.90 JP 262100/90**

(43) Date of publication of application :
01.04.92 Bulletin 92/14

(84) Designated Contracting States :
DE FR GB NL

(71) Applicant : **SHARP KABUSHIKI KAISHA**
22-22 Nagaike-cho Abeno-ku
Osaka 545 (JP)

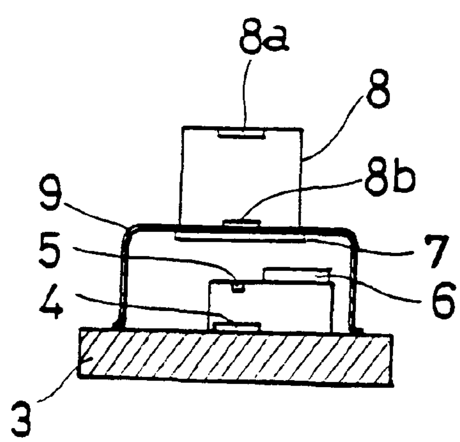
(72) Inventor : **Nagahama, Toshiya**
22-1-407, Kawarado-cho
Nara-shi, Nara-ken (JP)
Inventor : **Yamada, Shigehiro**
Mikasa dormitory, 492, Minosho-cho
Yamatokoriyama-shi, Nara-ken (JP)
Inventor : **Yokogawa, Naruichi**
192-1, Hajikami, Shinjo-cho
Kitakatsuragi-gun, Nara-ken (JP)
Inventor : **Seike, Yasushi**
Komei dormitory, 382-2, Iida,
Hachihonmatsu-cho
Higashihiroshima-shi, Hiroshima-ken (JP)
Inventor : **Yoshifusa, Koji**
44-181, Shoriki, Hachihonmatsu-cho
Higashihiroshima-shi, Hiroshima-ken (JP)

(74) Representative : **Brown, Kenneth Richard et al**
R.G.C. Jenkins & Co. 26 Caxton Street
London SW1H 0RJ (GB)

(54) Optical pickup using holographic optical element.

(57) An optical pickup using holographic optical element includes a light source, a lens system for converting an optical beam output from the light source onto a recording carrier, a photodetector for detecting reflected light from the recording carrier and a diffraction grating for introducing the reflected light from the recording carrier to the photodetector in a light path connecting the recording carrier and the light receiving element, the photodetector comprises a photodiode and a signal processing circuit which at least amplifies output signal of the photodiode.

FIG. 3



EP 0 478 222 A2

Jouve, 18, rue Saint-Denis, 75001 PARIS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an optical pickup used in an apparatus recording and reproducing an optical memory such as a compact disc player or a video disc player and, more particularly, to an optical pickup using holographic optical element in an optical system in order to reduce size and weight.

2. Description of the Prior Art

Fig. 8 is a view showing a structure of a conventional optical pickup using a diffraction grating. In Fig. 8, light output from a semiconductor laser (laser diode) 34 is input to a first diffraction grating (referred to as a grating hereinafter) 35 and then separated to zero-order diffracted light (referred to as a main beam hereinafter) for reading an information signal and a pair of ±1-order diffracted light (referred to as a sub-beam hereinafter) for tracking which separates in a direction almost vertical to a paper surface. These three beams pass through a second diffraction grating (referred to as a hologram hereinafter) 36, a collimator lens 37 and an objective lens 38 and then converge at a recording carrier (disc) 39. Then, the reflected light from the recording carrier 39 passes through the objective lens 38 and the collimator lens 37 and then diffracted by the hologram 36 and then its primary diffracted light is introduced to a photodetector 31.

Figs. 9 and 10 are views showing a grating pattern of the hologram 36 viewed from the recording carrier 39 and a pattern at a light receiving part of the photodetector 31, respectively. The hologram 36 comprises two regions 36a and 36b and the receiving part of the receiving element 31 comprises five regions 31a to 31e. The main beam diffracted in the region 36a of the hologram converges on a line between the light receiving parts 31a and 31b and the main beam diffracted in the region 36b converges in the light receiving part 31c. Then, two sub-beams converge in the light receiving parts 31d and 31e, respectively. Thus received light is converted to a current signal corresponding to a light intensity by the photodetector 31.

A current corresponding to each quantity of received light is generated from the light receiving parts 31a to 31e in the photodetector 31. The current is introduced into a current-voltage converting circuit positioned outside the optical pickup and converted to a voltage signal. Thereafter, a focus error signal (FES), a radial error signal (RES) and an information signal (RF) are generated by a signal operation circuit connected to the output of the current-voltage converting circuit. At this time, when signals output from the light receiving part 31a, 31b, 31c, 31d and 31e are designated by S_{31a}, S_{31b}, S_{31c}, S_{31d} and S_{31e}, FES = S_{31a} - S_{31b}, RES = S_{31d} - S_{31e} and RF = S_{31a} + S_{31b} + S_{31c}.

A structure of such optical pickup using holographic optical element is disclosed in "Optical Pickup" in Japanese Patent Laid Open No. 151022/1989.

However, optical utilization factor of the above optical pickup is lower, while the above optical pickup is smaller and its weight is less as compared with an optical pickup using a beam splitter of a half mirror instead of a diffraction grating. More specifically, in a case where the half mirror is used, a quantity of light input to the photodetector becomes 25% when the light passes through the half mirror both ways. However, according to the pickup using the diffraction grating, a quantity of light is 14% at most when the light passes through the diffraction grating both ways. Thus, when the quantity of light becomes about half, an S/N ratio is deteriorated. The S/N ratio is likely to be deteriorated in process of transmitting a signal from the photodetector 31 to the current-voltage converting circuit by a small current.

In addition, in a case where the signal processing circuit used together with the optical pickup is integrated corresponding to a signal level of the half mirror type optical pickup, the optical pickup using the holographic optical element whose signal level is about 1/2 can not be connected. Therefore, in a case where the optical pickup using the holographic optical element is used together with the signal processing circuit, an amplifying circuit for adjusting a gain has to be provided between the optical pickup and the signal processing circuit.

SUMMARY OF THE INVENTION

The present invention was made in order to solve above problems and it is a general object of the present invention to provide an optical pickup using a hologram optical element in which an S/N ratio of an output signal from a photodetector can be improved.

According to the present invention, an optical pickup using holographic optical element comprising a light source, a lens system for converting an optical beam output from the light source onto a recording carrier, a photodetector for detecting reflected light from the recording carrier and a diffraction grating for introducing the reflected light from the recording carrier to the photodetector in a light path connecting the recording carrier and the photodetector, the photodetector comprising a photodiode and a signal processing circuit which at least amplifies output signal of the photodiode.

According to the present invention, the photodiode of the photodetector detects reflected light introduced from the recording carrier by the diffraction grating and outputs a signal. This output signal is input to the signal processing circuit. The signal processing

circuit at least amplifies the output signal and then outputs it to the outside. Thus, weakening of the output signal which is caused by a lack of light generated by the diffraction grating and input to the photodiode is prevented. Therefore, the S/N ratio is improved.

As described above, even if the diffraction grating whose light utilization factor is small is used, it is possible to obtain an output signal having a good S/N ratio and also possible to reduce the number of parts.

DESCRIPTION OF THE DRAWINGS

An embodiment of the invention will now be described by way of example and with reference to the accompanying drawings, in which:

Fig. 1 is a plan view showing a structure of a photodetector in accordance with an embodiment of the present invention;

Figs. 2 and 3 are a perspective view and a partially omitted longitudinal sectional view, respectively, each showing a structure of a laser unit of the embodiment of the present invention;

Fig. 4 is a circuit diagram showing a structure of a signal processing circuit in accordance with a first embodiment of the present invention;

Fig. 5 is a circuit diagram showing a structure of a signal processing circuit in accordance with a second embodiment of the present invention;

Fig. 6 is a circuit diagram showing a structure of a signal processing circuit in accordance with a third embodiment of the present invention;

Fig. 7 is a circuit diagram showing a structure of a signal processing circuit in accordance with a fourth embodiment of the present invention;

Fig. 8 is a schematic view showing a whole structure of an optical pickup;

Fig. 9 is a plan view showing a grating pattern of a hologram of the optical pickup; and

Fig. 10 is a plan view showing a pattern at a light receiving part of a conventional photodetector.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The overall structure except for a structure of a photodetector of an optical pickup in accordance with an embodiment of the present invention is the same as that shown in Fig. 8, so that its description is omitted.

Fig. 2 is a perspective view showing an inside structure of a laser unit in accordance with the embodiment of the present invention and Fig. 3 is a longitudinal sectional view showing the laser unit.

In the laser unit 1, a monitor photodiode 4, a laser diode 5 serving as a light source and a light receiving element 6 are arranged on a stem 3 having lead pins 2 for connection to the outside. In addition, a cap 9 having a cap glass 7 and a hologram glass 8 at the upper side so as to protect these elements is provided on the stem 3. The hologram glass 8 comprises a hologram pattern 8a and a grating pattern 8b.

As shown in Fig. 1, the photodetector 6 comprises five photodiodes D1, D2, D3, D4 and D5 and a signal processing circuit 10 which amplifies at least output signals from the photodiodes D1 to D5.

Fig. 4 is a view showing a first structure of the signal processing circuit 10. In Fig. 4, a signal processing circuit 101 comprises transistors TR1, TR2, TR3, TR4 and TR5 which are provided corresponding to the photodiodes D1, D2, D3, D4 and D5, respectively. More specifically, a base of each of the transistors TR1 to TR5 is connected to an anode of each of the photodiodes D1 to D5 and each collector is connected to a cathode of each of the photodiodes D1 to D5 and to a power supply line 11 connected to an outside grower supply. An emitter of each of the transistors TR1 to TR5 is connected to the pin 2 and becomes an output end of the photodetector 6.

The signal processing circuit 101 is a current amplifying circuit which amplifies a current output corresponding to a quantity of light received by the photodiodes D1 to D5 and outputs it. Therefore, because the level of the output current of the photodetector 6 is larger than that of the conventional one, influence of disturbance is comparatively small and degradation of the S/N ratio is reduced. The level of the output current may be adjusted by adjusting the amplification degree of the transistors TR1 to TR5 in accordance with the input level of an I-V converting circuit of a latter stage or the signal processing circuit.

Fig. 5 is a view showing a second structure of the signal processing circuit 10. In Fig. 5, a signal processing circuit 102 is an I-V (current-voltage) converting circuit comprising operational amplifiers OP1, OP2, OP3, OP4 and OP5. An (-) input of each of the operational amplifiers OP1 to OP5 is connected to an anode of each of the photodiodes D1 to D5 and (+) input is connected to a ground GND.

A current generated in each of the photodiodes D1 to D5 is converted to a voltage by each of the operational amplifiers OP1 to OP5 and then output. In this case, connection to the outside signal operating circuit can be easily implemented by setting the amplification degree of each of the operational amplifiers OP1 to OP5 in accordance with sensitivity of each of the photodiodes D1 to D5.

Fig. 6 is a view showing a third structure of the signal processing circuit. In Fig. 6, a signal processing circuit 103 is an I-V converting and signal operation circuit comprising three operational amplifiers OP6, OP7 and OP8. More specifically, the operational amplifier OP6 performs operation in which the output current of the photodiode D1 is subtracted from the output current of the photodiode D5 to output the radial error signal RES. The operational amplifier OP7 performs addition by adding the output current of the

photodiodes D2, D3 and D4 and then outputs the information signal RF. In addition, the operational amplifier OP8 performs subtraction by subtracting the output current of the photodiode D2 from the output current of the photodiode D3 and then outputs the focus error signal FES.

In this third structure, the respective signals output from the signal processing circuit 103 are voltage signals. More specifically, in each of the operational amplifiers OP6, OP7 and OP8, current-voltage conversion, amplification and each operation are performed. Therefore, the output signal is not likely to be influenced by disturbance and deterioration of the S/N ratio is reduced. In addition, the signal is output in the form of the focus and radial error signals and information signal, so that the outer circuit capable of being connected in this embodiment may be a common circuit which can process these signals. Thus, for example, it is not necessary to consider a difference of operation process of generation of the focus error signal when the outer circuit is determined.

Fig. 7 is a view showing a fourth structure of the signal processing circuit 10.

In Fig. 7, a signal processing circuit 104 comprises five operational amplifiers OP11 to OP15, resistors R1 to R3 and capacitors C1 to C3. The operational amplifier OP11 converts the output current of the photodiodes D2, D3 and D4 to a voltage and also adds and outputs them. The capacitors C1 to C3 are for DC cutting. The operational amplifiers OP12 and OP13 operate as I-V converting circuits. More specifically, it amplifies the current signals output from the photodiodes D1, D2, D3 and D5 and also converts them to a voltage and then output them.

In the fourth structure, the output signal of the photodiode D4 is not output alone. More specifically, the signal processing circuit 104 outputs the information signal RF (V_{RF}), so that the radial and focus error signals necessary for servo control can be operated by the output signals of the photodiodes D1, D2, D3 and D5. Thus, in this structure, various signal operating circuits can be connected.

In addition, the photodetector in the above embodiments of the present invention is manufactured by forming the photodiode and the signal processing circuit on the same semiconductor substrate. In the manufacturing process, well-known technique of manufacturing an integrated circuit is used.

While only certain presently preferred embodiments have been described in detail, as will be apparent with those skilled in the art, certain changes and modifications can be made without departing from the scope of the invention as defined by the following claims.

Claims

1. An optical pickup using holographic optical element comprising:

    a light source;

    a lens system for converting an optical beam output from the light source onto a recording carrier;

    a photodetector for detecting reflected light from the recording carrier; and

    a diffraction grating for introducing the reflected light from the recording carrier to the light receiving element in a light path connecting the recording carrier and the photodetector,

    the photodetector comprising a photodiode and a signal processing circuit which at least amplifies output signal of the photodiode.

2. An optical pickup as set forth in claim 1, wherein the signal processing circuit shares a power supply with the photodiode and has a plurality of transistors connected corresponding to each photodiode and amplifies and outputs an output signal of the photodiode to an output end of the photodetector.

3. An optical pickup as set forth in claim 1, wherein the signal processing circuit has a plurality of operational amplifiers connected corresponding to each photodiode and converts the output signal of the photodiode to a voltage and then outputs it to the output end of the photodetector

4. An optical pickup as set forth in claim 1, wherein the signal processing circuit has a plurality of operational amplifiers operating an output current of the photodiode and converts the operational result to a voltage and then outputs it to the output end of the photodetector.

5. An optical pickup as set forth in claim 1, wherein the signal processing circuit comprises the operational amplifier which converts the output current of the photodiode to a voltage and the operational amplifier which adds the voltage after conversion.

6. An optical pickup as set forth in claim 1, wherein the photodetector comprises the photodiode and the signal processing circuit formed on the same semiconductor substrate.

7. An optical pickup device (1) for an optical reproduction apparatus in which data recorded on a data carrier is read using an optical beam focused onto said carrier, light reflected from the carrier being deflected by a diffraction grating (8a) toward a photoelectric detecting means (6), said

pickup device including said photoelectric detecting means for receiving the deflected light, characterised in that said pickup device also includes circuitry (10) coupled to said photoelectric detecting means for performing signal amplification, said circuitry (10) and said photoelectric detecting means (6) being incorporated in a common unit.

8. A device according to claim 7, wherein said unit includes a base plate (3) on which said circuitry (10) and said photoelectric detecting means (6) are mounted, and electrical connection elements (2) supported by said base plate and connected to the circuitry, for coupling amplified signals derived from the photoelectric detecting means to circuitry external to said unit.

FIG. 1

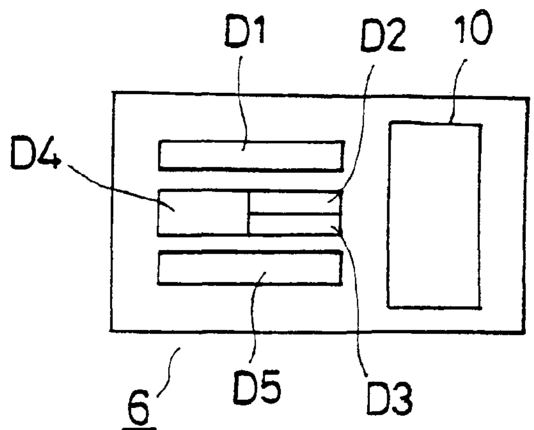


FIG. 2

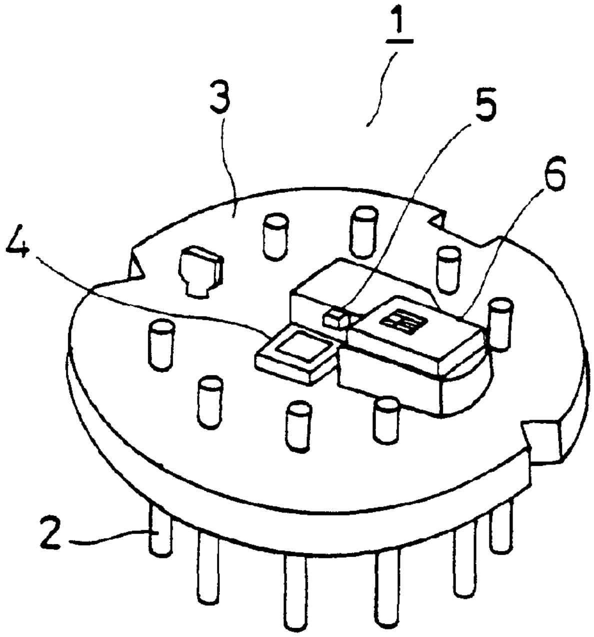


FIG. 3

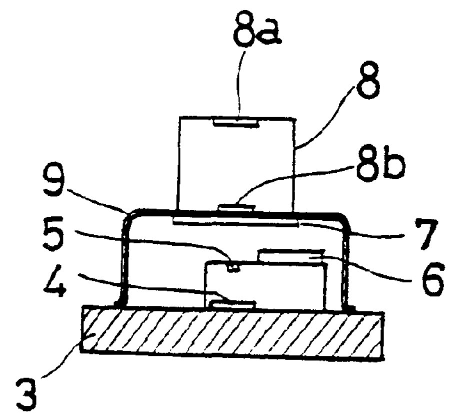


FIG. 4

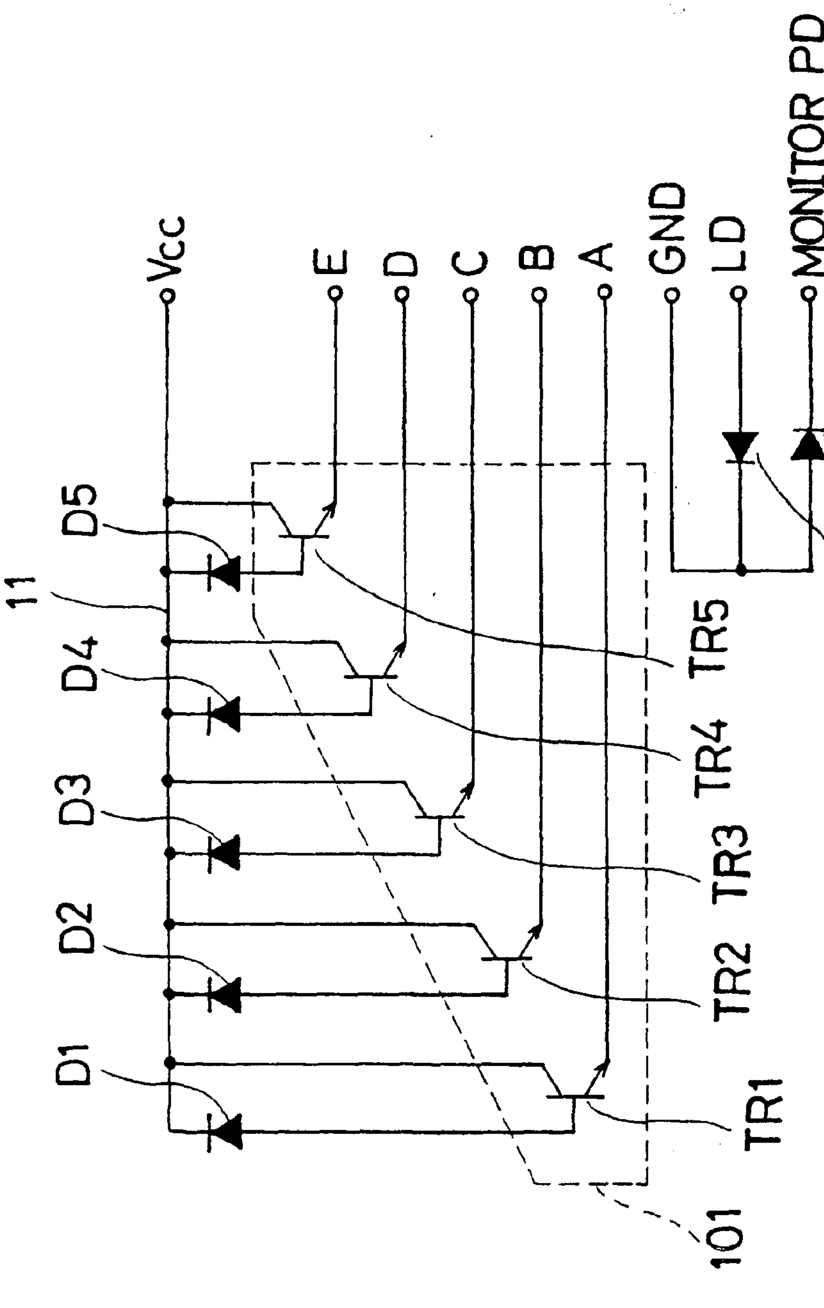

Vcc
E
D
C
B
A
GND
LD
MONITOR PD
D1
D2
D3
D4
D5
11
TR1
TR2
TR3
TR4
TR5
101
5
4

FIG. 5

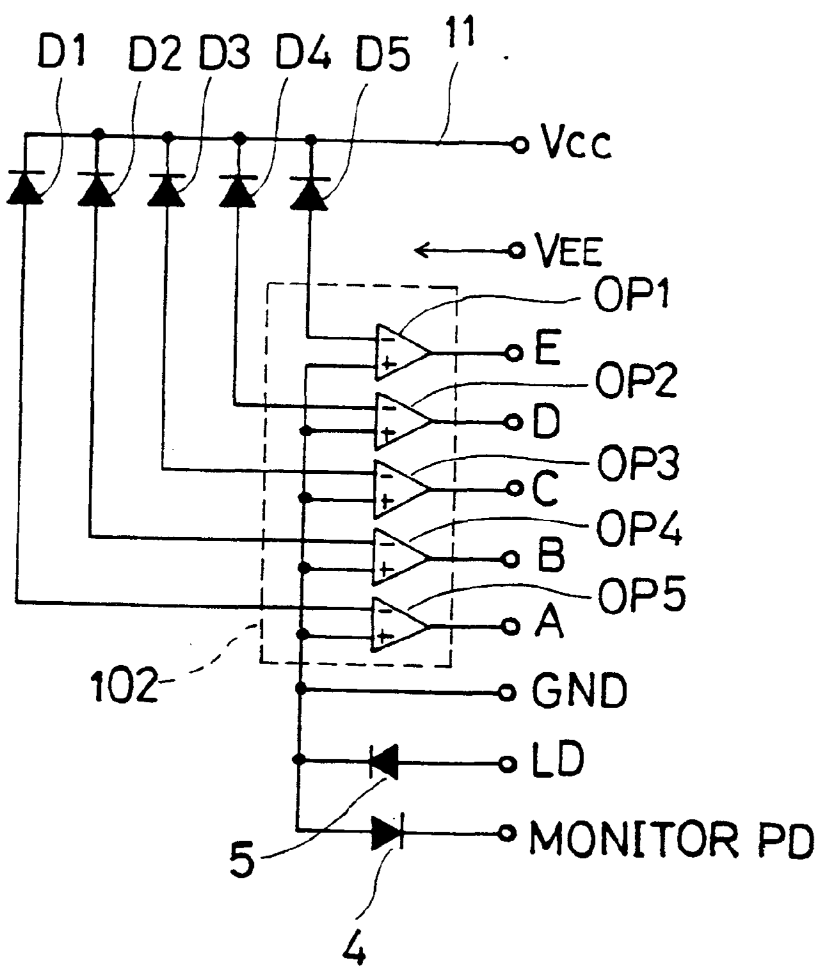
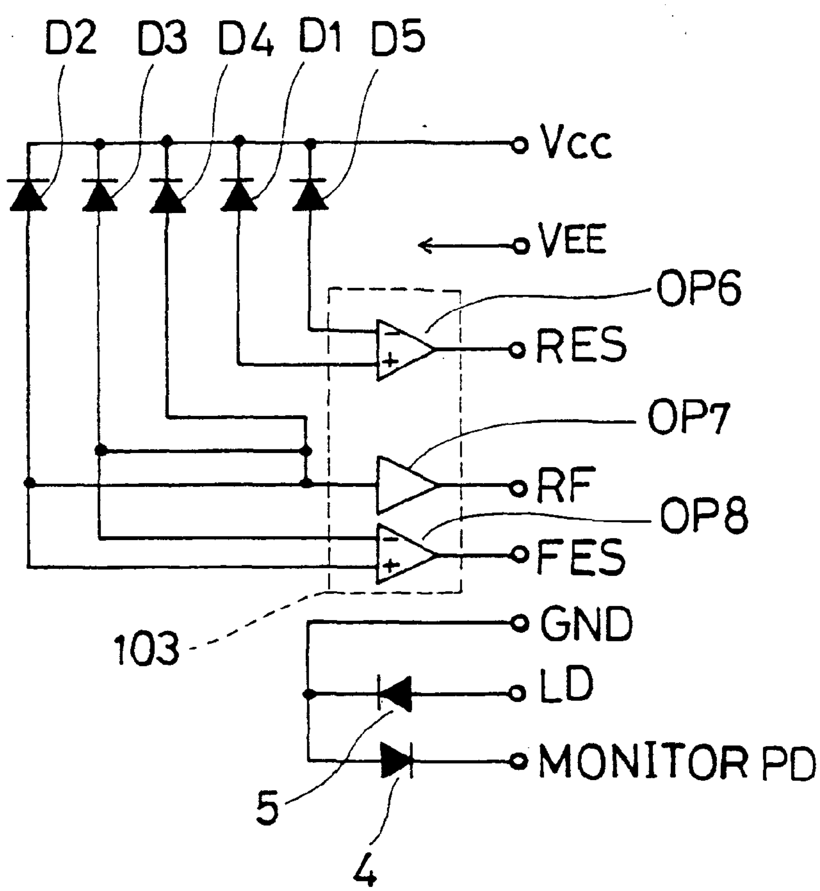

D1
D2
D3
D4
D5
11
Vcc
VEE
OP1
E
OP2
D
OP3
C
OP4
B
OP5
A
102
GND
LD
MONITOR PD
5
4

FIG. 6


D2
D3
D4
D1
D5
Vcc
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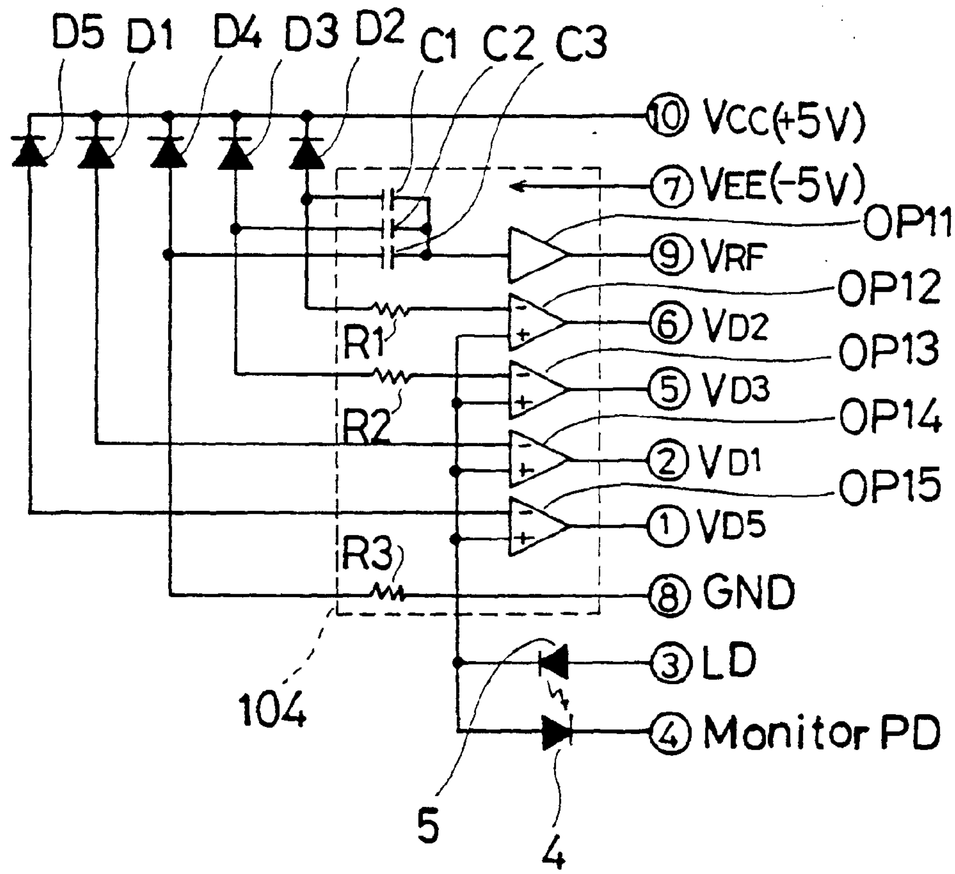
OP6
RES
OP7
RF
OP8
FES
103
GND
LD
MONITOR PD
5
4

FIG. 7


D5
D1
D4
D3
D2
C1
C2
C3
⑩ Vcc(+5V)
⑦ VEE(-5V)
OP11
⑨ VRF
OP12
⑥ VD2
OP13
⑤ VD3
OP14
② VD1
OP15
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⑧ GND
③ LD
④ Monitor PD
R1
R2
R3
104
5
4

FIG. 8

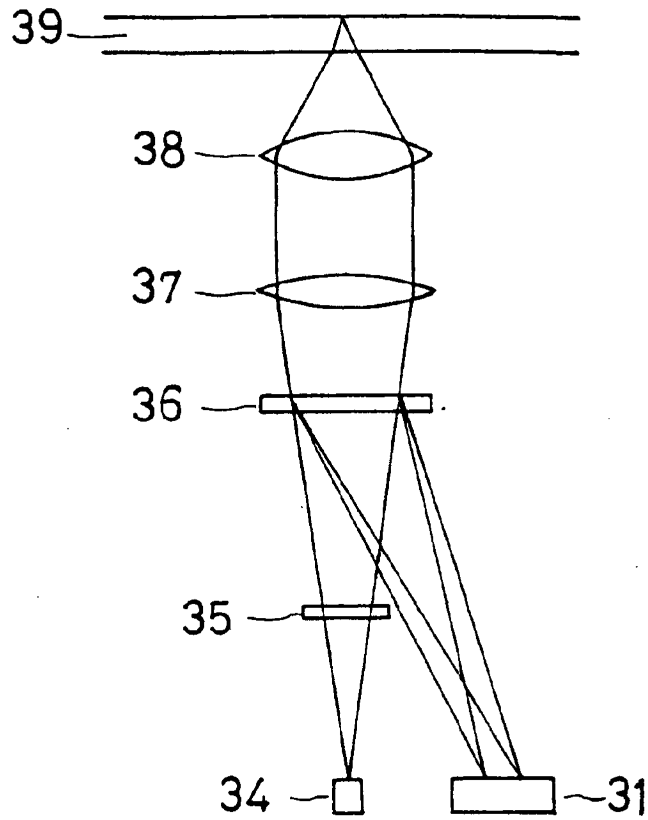


FIG. 9

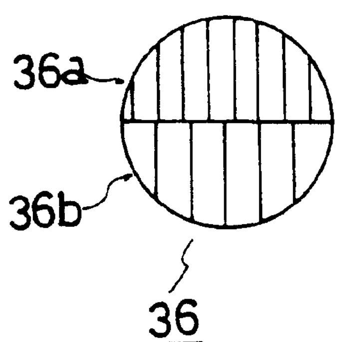
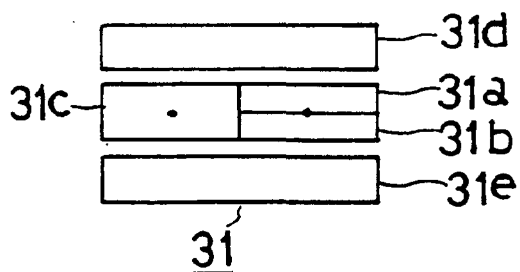


FIG. 10



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(88) Date of deferred publication of search report : **16.12.92 Bulletin 92/51**

(71) Applicant : **SHARP KABUSHIKI KAISHA**
22-22 Nagaike-cho Abeno-ku
Osaka 545 (JP)

(72) Inventor : **Nagahama, Toshiya**
22-1-407, Kawarado-cho
Nara-shi, Nara-ken (JP)
Inventor : **Yamada, Shigehiro**
Mikasa dormitory, 492, Minosho-cho
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192-1, Hajikami, Shinjo-cho
Kitakatsuragi-gun, Nara-ken (JP)
Inventor : **Seike, Yasushi**
Komei dormitory, 382-2, Iida,
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Higashihiroshima-shi, Hiroshima-ken (JP)
Inventor : **Yoshifusa, Koji**
44-181, Shoriki, Hachihonmatsu-cho
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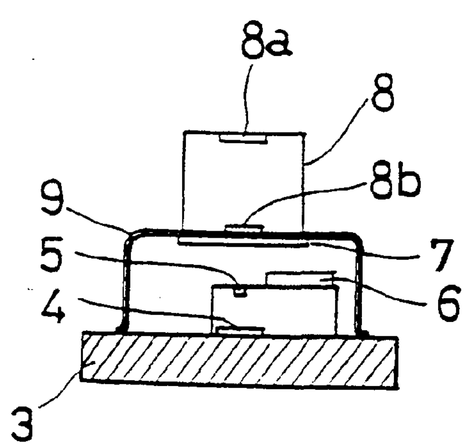
FIG. 3



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EUROPEAN SEARCH REPORT

Application Number

EP 91308539.5

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	EP - A - 0 320 276 (SHARP K.K.) * Fig. 1-7; abstract * --	1,7	G 11 B 7/135 G 11 B 7/12 G 11 B 7/13
Y	DE - A - 3 928 931 (TOSHIBA K.K.) * Fig. 2; abstract * --	1,7	
A	PATENT ABSTRACTS OF JAPAN, unexamined applications, P field, vol. 11, no. 208, July 7, 1987 THE PATENT OFFICE JAPANESE GOVERNMENT page 70 P 593 * Kokai-no. 62-28 938 (MITSUBISHI ELECTRIC CORPORATION) * ----	1-8	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			G 11 B 7/00 G 01 J 1/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	20-10-1992	BERGER

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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